PNWS AWWA Conference – Boise Idaho

Friday Harbor's Battles with Organics: Looking at Every Tool Under the Sun

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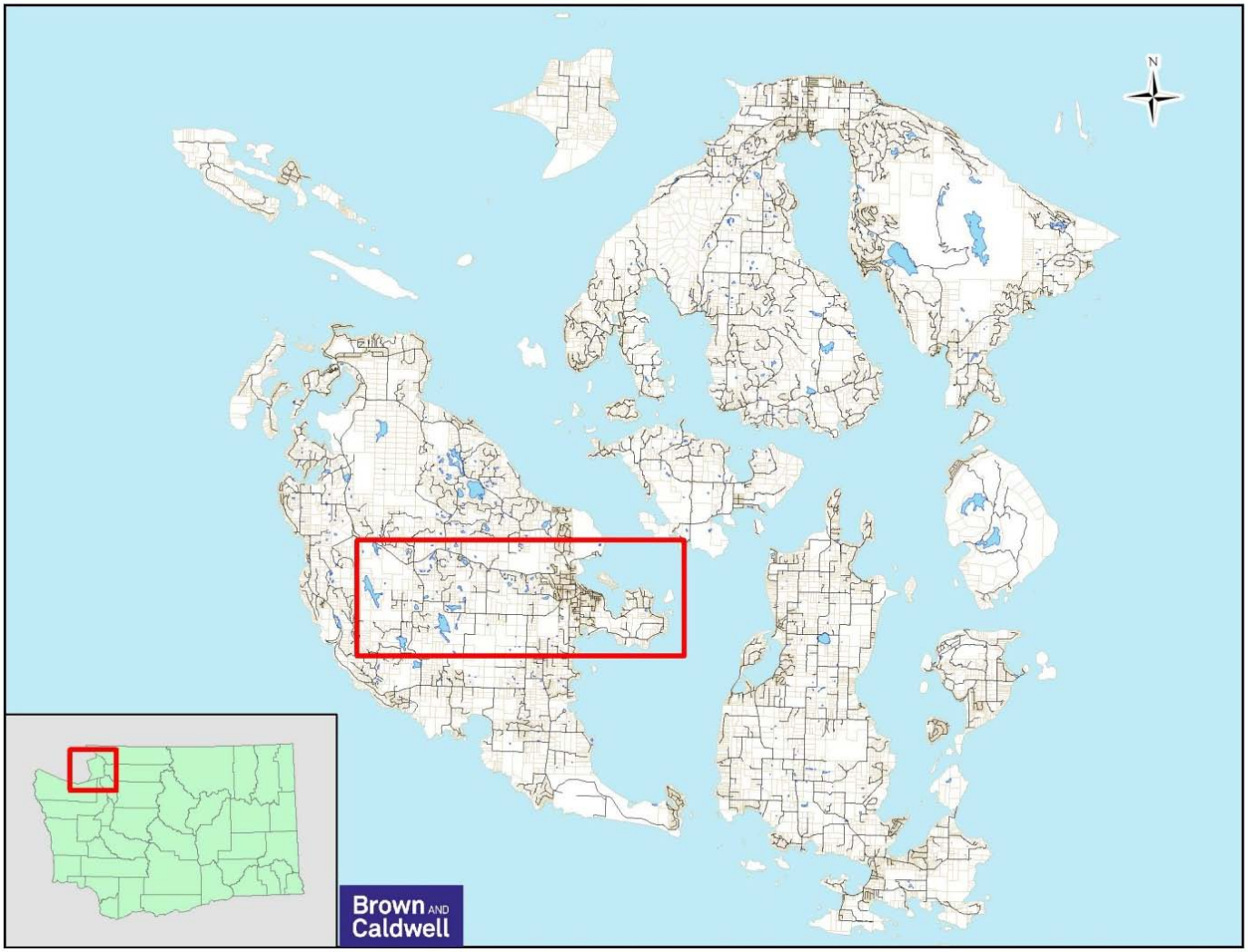
Presentation Overview

- The Community
- The Water System
- The Water Quality Problem
- The Solution Alternatives
- The Chosen Solution

The Community

- Town of Friday Harbor, WA
  - Located on San Juan Island
  - Summer tourism center
- Resident water service population of totals approximately 3,300
  - 2,300 in Town
  - 900 in surrounding unincorporated areas

San Juan Islands and Friday Harbor Vicinity



Water System Map

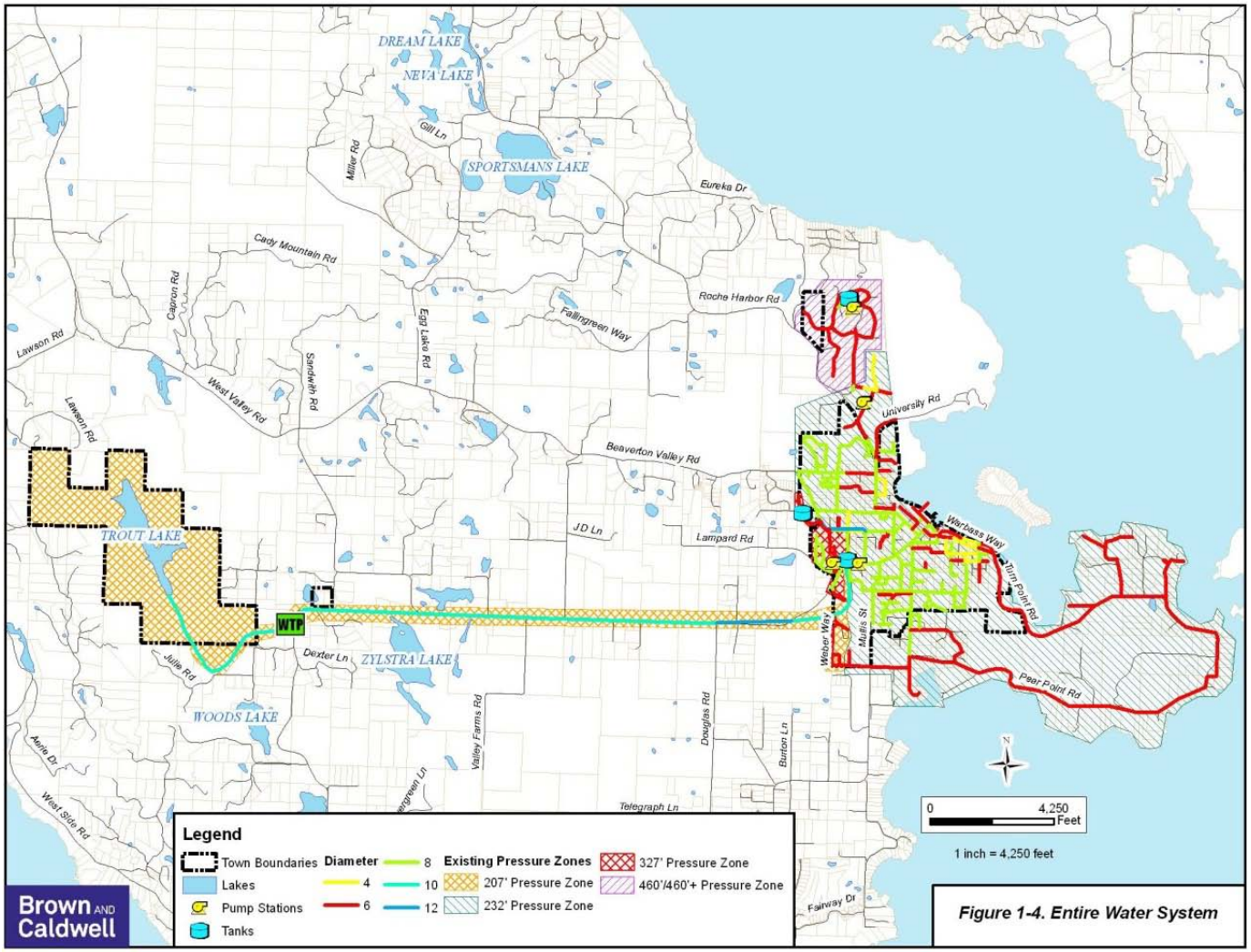


Figure 1-4. Entire Water System

Surface Water Supply Source

- Trout Lake Impoundment
- Concrete arch dam constructed in 1928
- AUG 1 and 2 supplemental seasonal supplies pumped to Trout Lake storage
- Forested and vegetated watershed

Trout Lake Surface Water Supply and Watershed

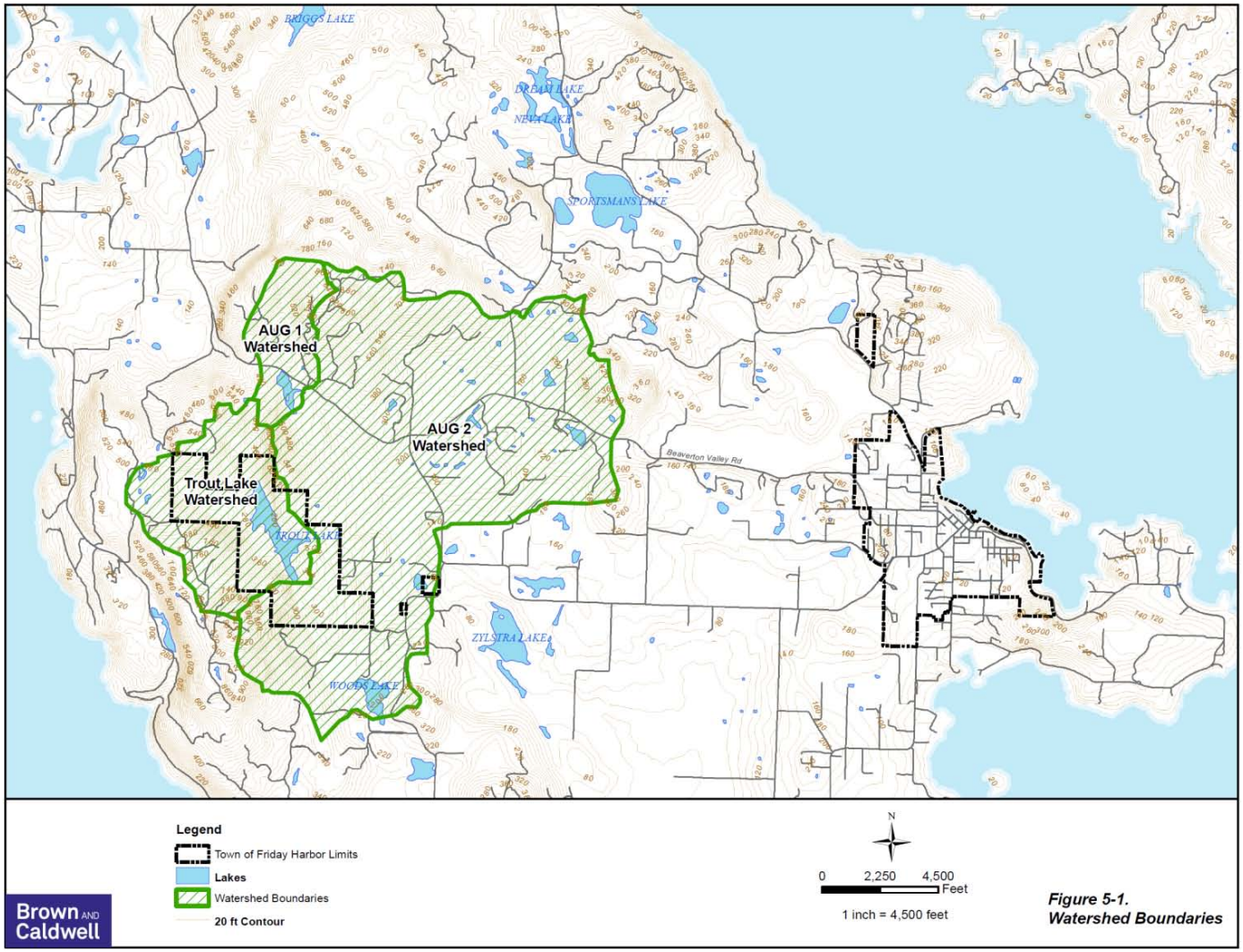


Figure 5-1. Watershed Boundaries

Watershed Land Use
Forest Resource and Rural Farm Forest

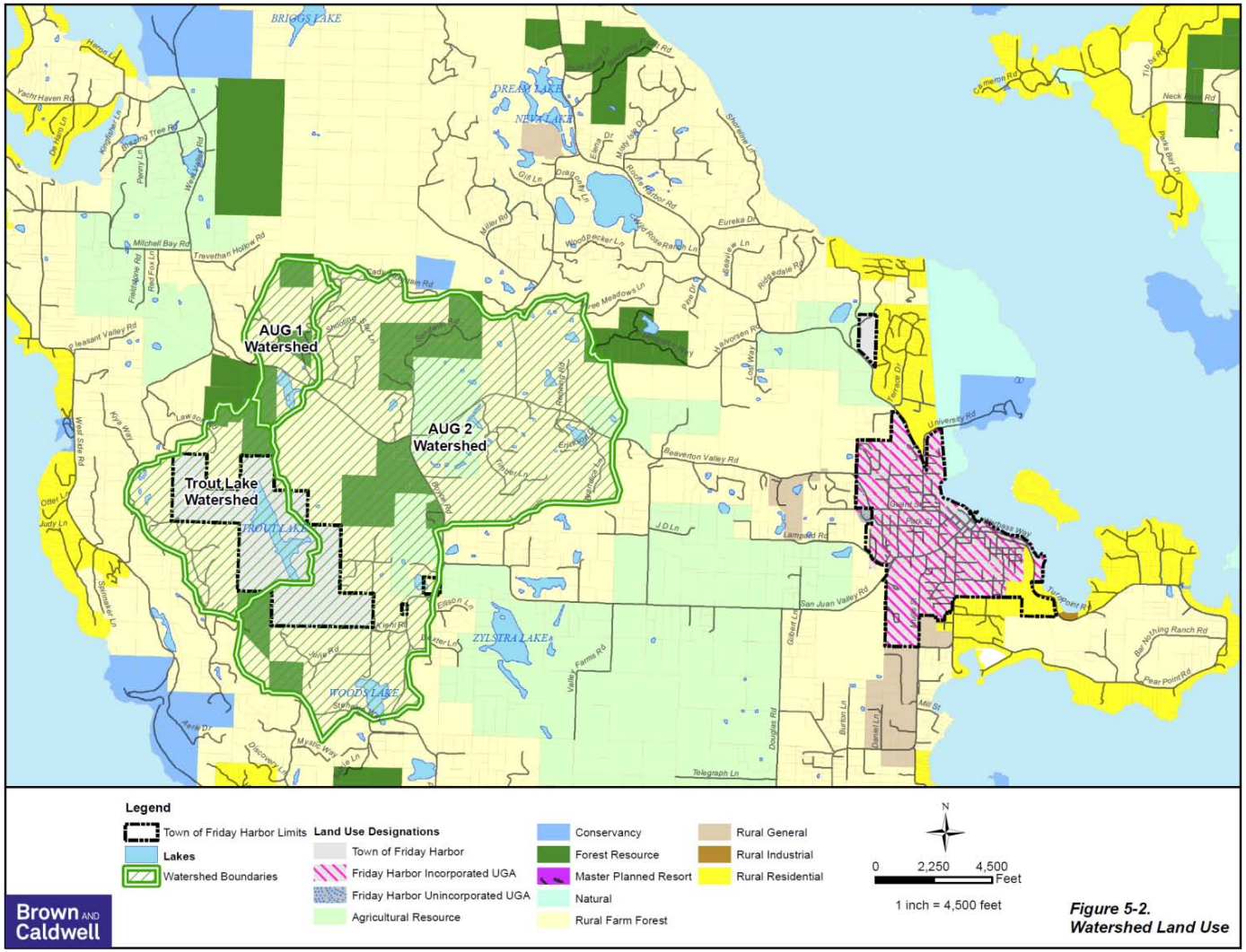


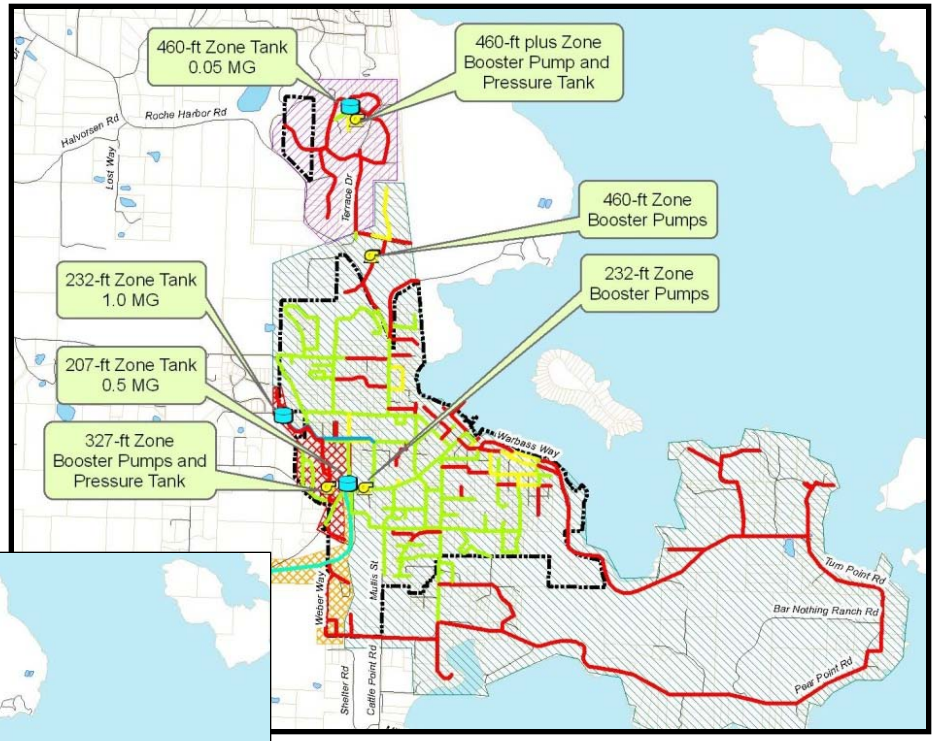
Figure 5-2. Watershed Land Use

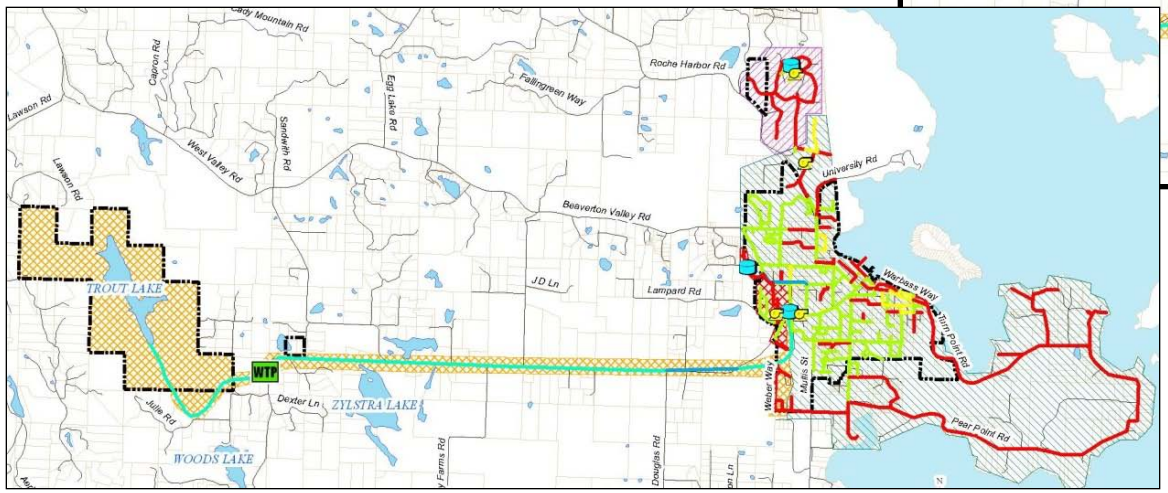
Water Treatment

- Direct filtration package treatment system
- 1995 Construction
- 1.0 mgd capacity
- Pre-disinfection and coagulation addition
- Upflow contact clarifiers
- Rapid sand filters
- Chlorine disinfection

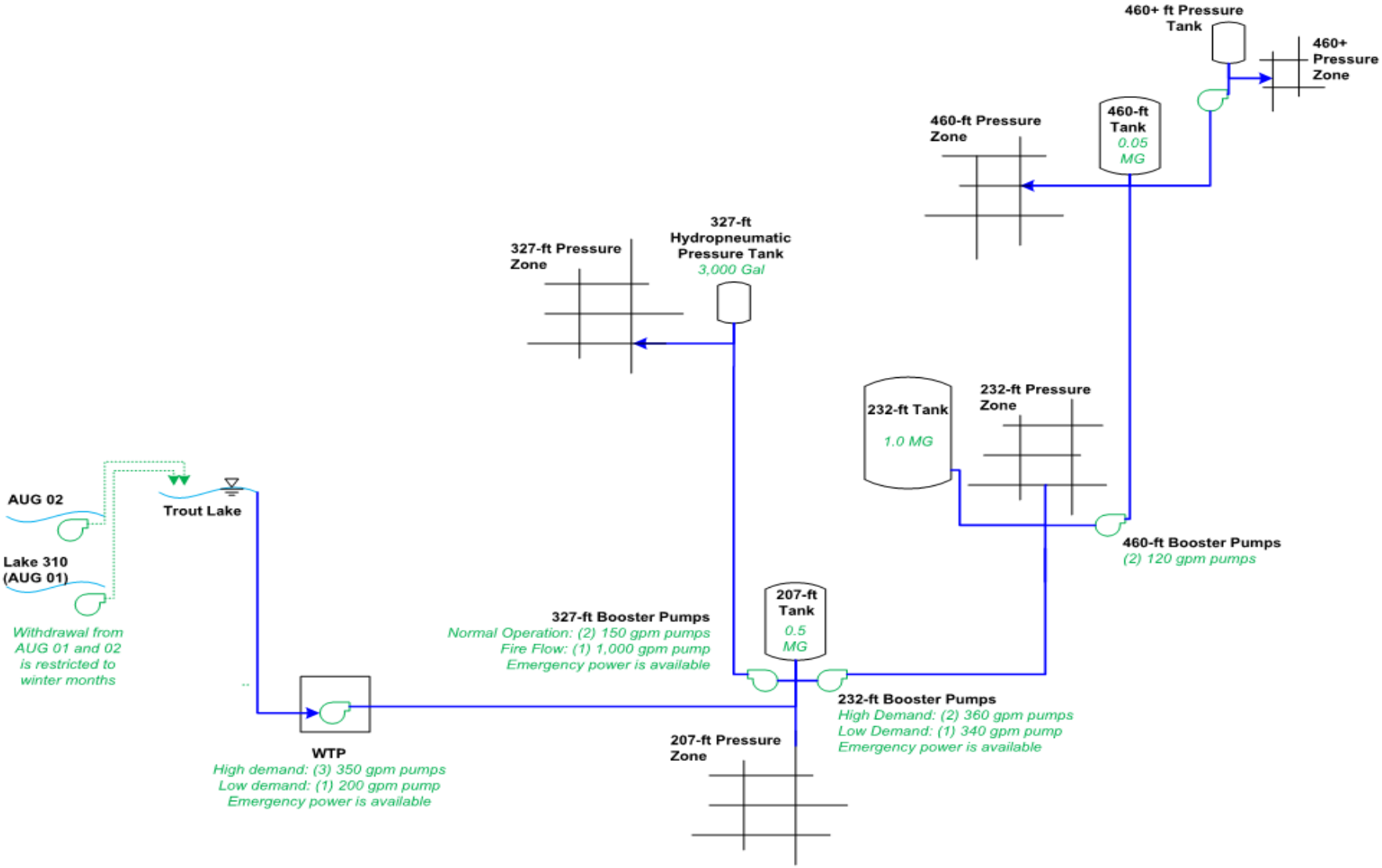
Water Supply System

- 35+ miles of water mains
- 3 in town storage tanks
- 5 pressure zones
- No re-chlorination

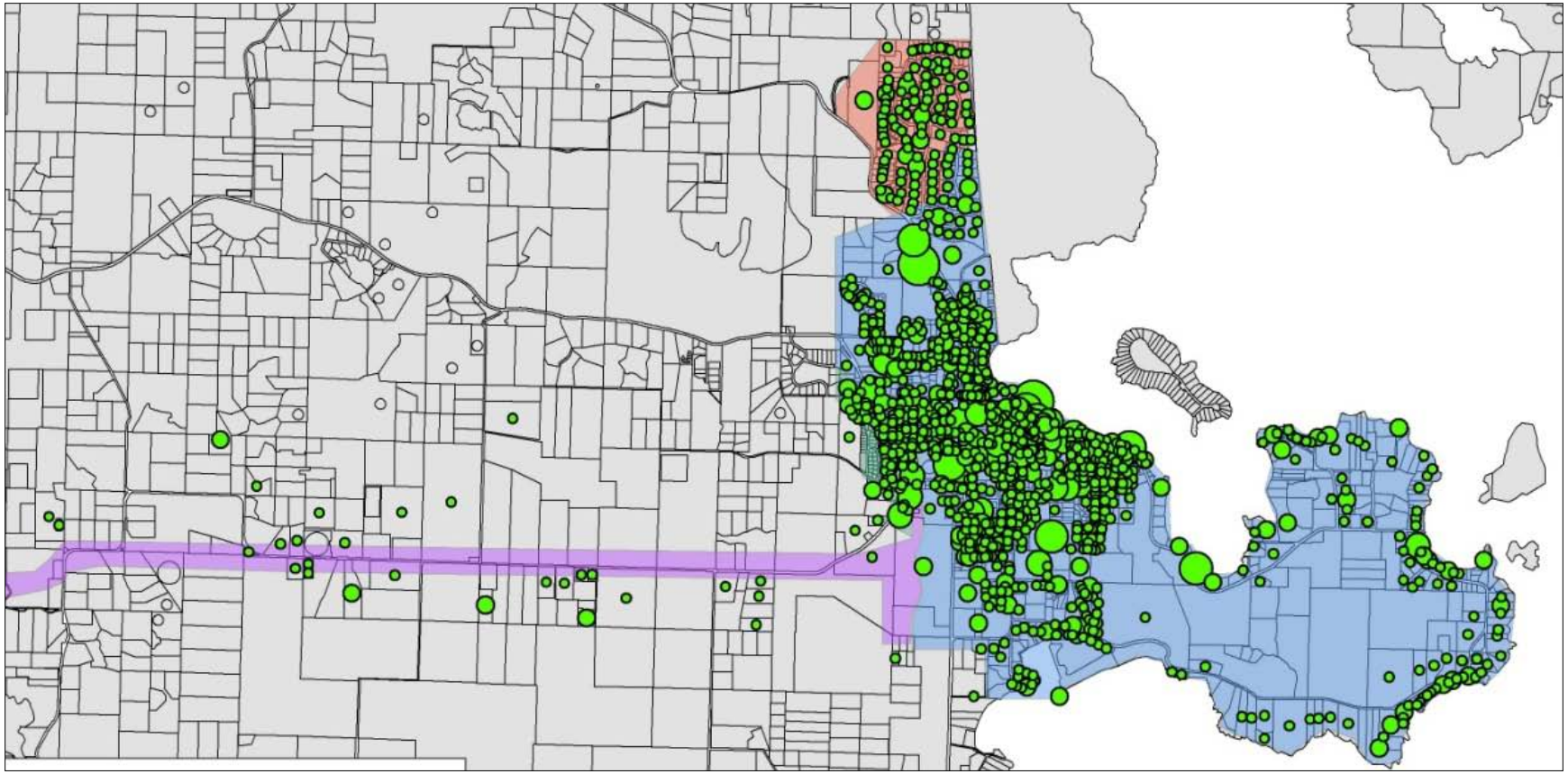




Water System Schematic



Water Demand Distribution



The Water Quality Problem

- Disinfection byproduct formation (DBPs)
  - Total Trihalomethanes (TTHM)
  - Haloacetic Acids (HAA5)
  - Some Maximum Contaminant Level (MCL) violations
- High total organic carbon (TOC) levels
- Seasonal algae issues in Trout Lake
- Seasonal taste and odor (T&O) complaints

DBPs and TOC

Friday Harbor Water Quality History		
Constituent	Concentration	MCL
Finished water TTHM	0.080 to 0.125 mg/L	0.080 mg/L
Finished water HAA5	0.040 to 0.050 mg/L	0.060 mg/L
Raw water TOC	6 to 8 mg/L	- -

Ranked Solution Alternatives – 2001

- Suspend pre-chlorination
- Frequent distribution system flushing
- Oxidize DBP precursor and T&O compounds with potassium permanganate
- Adsorb DBP precursor and T&O compounds with powdered activated carbon
- New coagulants and enhanced coagulation
- Air strip chloroform THMs
- Reduce algae formation in Trout Lake
- Install granular activated carbon (GAC) cap on existing filters
- Install inline GAC contactor filtration
- Switch from free chlorine disinfection to chloramination
- Chlorine dioxide disinfection
- Ultraviolet (UV) disinfection
- Ozone disinfection system to oxidize DBP precursor and T&O compounds

Water Quality Improvement Approach and History Since 2001

- Study and assess solution alternatives
  - Implement low cost solutions first
  - Realized sufficient improvement to meet water quality regulations
  - Further water quality improvement desired
  - Review additional measures to improve water quality
- Lower cost solutions ultimately not considered good enough
- Ultimately adopted one final water quality solution

Initial Steps Implemented – 2003

- Suspend pre-chlorination
- More frequent distribution system flushing
- Solar Bee mixers installed to limit Trout Lake algae formation
- Implement pre-oxidation with potassium permanganate
  - 0.5 to 2.5 mg/L applied dose
- TTHM values reduced to just below 0.080 mg/L MCL

Ozone Disinfection Study – 2006

- Potential benefits
  - Oxidize DBP precursor and T&O compounds
  - Lower chlorine dose and reduced dependence on chlorine disinfection
  - DBP reduction
  - Reduce T&O complaints
- Conduct ozone pilot study to assess performance

Ozone Pilot Study Results

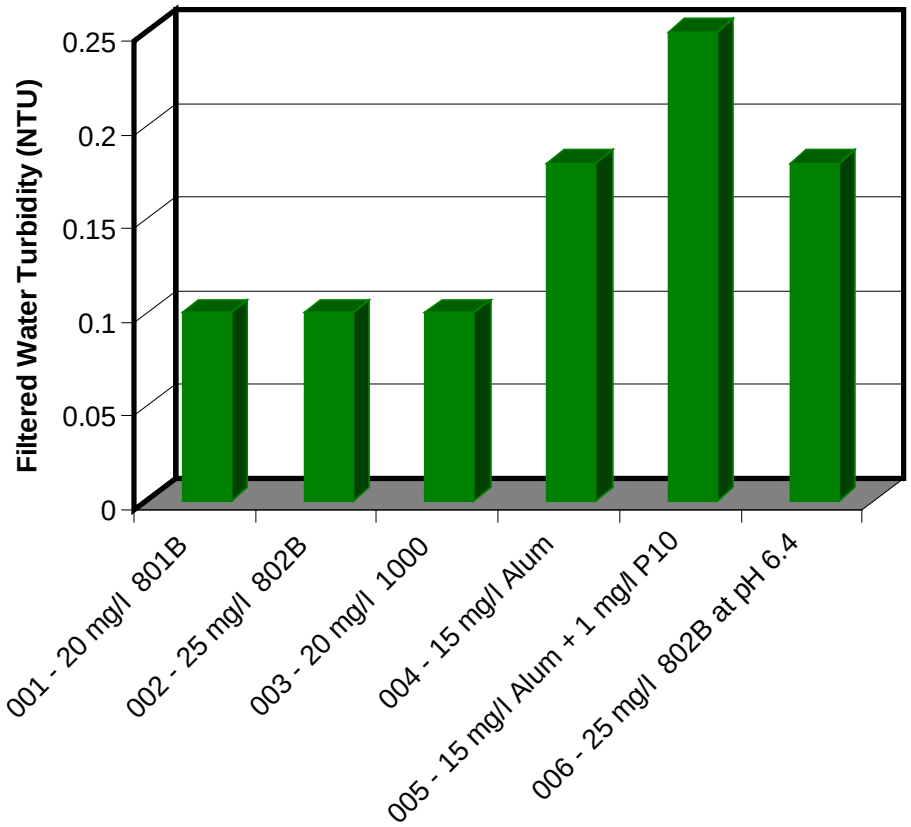
- 1.0 to 1.5 mg/L ozone
- DBP levels reduced to below half of MCLs
- Eliminates T&O issues
- Excellent water quality with good aesthetics
- Capital implementation costs estimated at greater than $1.0M

Enhanced Coagulation Trials – 2008

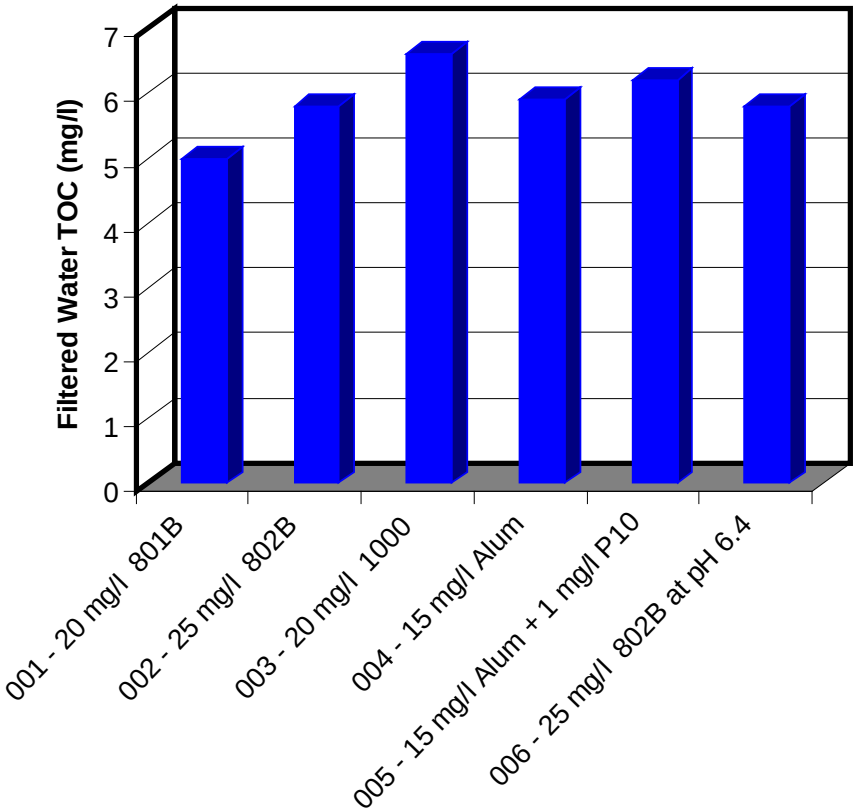
- Limited TOC removal via prior flocculation processes
- Jar and filterability analysis
- Test for optimal coagulation chemicals, dosages, and flocculation schemes
- Identified some potential to improve TOC removal

Enhanced Coagulation Trial Results

Filtered Water Turbidity



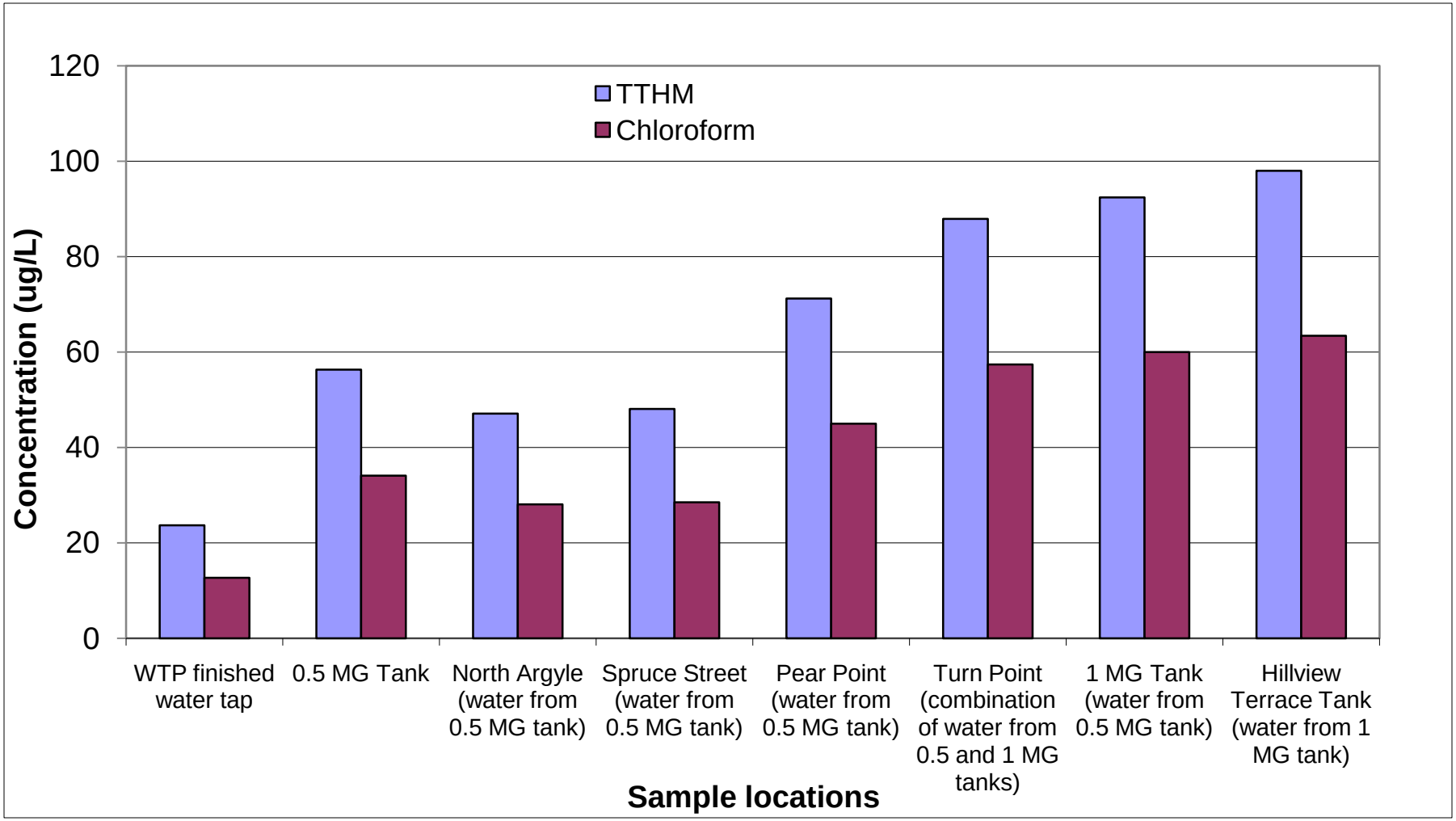
Filtered Water TOC



Air Stripping Removal of THM Chloroform Species – 2009

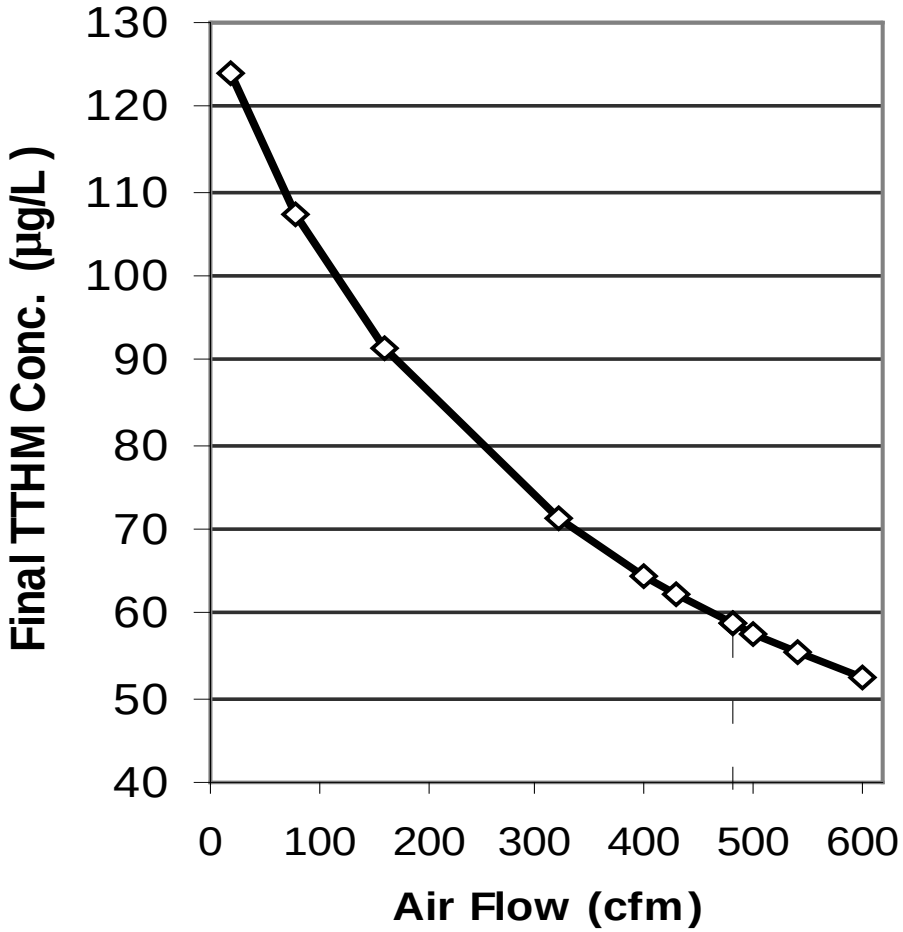
- Chloroform is the predominant THM DBP constituent at Friday Harbor
  - Approximately 2/3 of TTHM is chloroform
  - Chloroform is a volatile compound
  - Can be removed via air stripping after formation
  - Henry's Law Constant, H = 0.138 (20^0C)

TTHM Fraction as Chloroform at Friday Harbor



Chloroform Air Stripping Analysis Results

- Consider air blower and diffuser system installed at water storage tanks
  - 320 to 480 scfm air flow
  - TTHM values expected from 0.050 to 0.070 mg/L
- Some concern over air emissions
- Operating costs projected at less than $15,000/year
- Problem: chloroform continues to form following air stripping process



GAC: The Final Solution – 2010

- Post filtration GAC @ EBCT = 14 minutes
- Adsorbs DBP precursor and T&O compounds
- Analogous success at nearby Roche Harbor
- Low DBP levels expected
  - TTHM @ approximately 0.025 mg/L
  - HAA5 @ approximately 0.010 mg/L
- GAC life expected @ 8 to 12 months
- Corrects T&O issues
- Economics (cost/benefit) are acceptable
  - $1,000,000 capital
  - $100,000/year operating

Dual GAC Contactor Installation – 2011

Summary

- Multiple DBP treatment approaches investigated
- Solution priorities
  - Cost and economics
  - Public health and regulatory water quality compliance
  - Aesthetic water quality (i.e. T&O issues)
- Assessed and implemented through orderly, cost ranked approach
- GAC was the Town's ultimate preferred solution, in part due to excellent aesthetic water quality

Be on the lookout for a fierce new contender at the 2012 PNWS AWWA Best Tasting Water Competition!

Questions and Discussion

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